

Coatings Activities Related to GSI-191 Resolution

NEI PWR Sump Task Force
Coatings Sub-Task Group

Coatings Activities Related to GSI-191 Resolution

- Current Containment Coatings Monitoring and Maintenance Practices
- Confirmation of Adequacy of Current Practices
- Coatings Failure Morphology Investigations

Current Containment Coatings Monitoring and Maintenance Practices

- Regulatory Guidance Provided in Regulatory Guide 1.54 Rev. 1 and NUREG 1801 (GALL Report)
- Industry Guidance Commensurate with RG 1.54 and NUREG 1801 Provided in ASTM D 5163
- ASTM D-33 meeting with nuclear organizations from other countries to determine monitoring and maintenance practices

Confirmation of Adequacy of Current Practices

- EPRI initiated a Task in September, 2005 entitled, “Evaluation of Coating Failures and the Potential Influence of Aging”
- EPRI Task will be executed in four Sub-Tasks

Confirmation of Adequacy of Current Practices

- EPRI Sub-Task 1 – complete Nuclear Utility Coatings Council (NUCC) Survey 2005-07, “Nuclear Industry Coatings Failure” and develop a detailed report that presents and discusses the survey results
 - Status – EPRI Report 1013465, “Plant Support Engineering: Aging and Degradation Survey for Nuclear Service Level 1 Coatings” to be issued in December 2006

Confirmation of Adequacy of Current Practices

- EPRI Sub-Task 2 – Review and evaluate industrial coating failures and their associated failure mechanisms for applicability to the recent nuclear industry failures
 - Status – EPRI Report to be issued by Spring 2007

Confirmation of Adequacy of Current Practices

- EPRI Sub-Task 3 – Perform coating adhesion testing to correlate visual appearance and adhesion values with original coating condition when first DBA-qualified
 - Status – EPRI Report to be issued during 2007

Confirmation of Adequacy of Current Practices

- Use of pull-off adhesion testing (ASTM D 4541) performed by industry experts to validate visual inspection of containment coatings
- To date, two plants tested:
 - SONGS – Mobil/Valspar coatings on steel and concrete
 - Waterford – Carboline and Ameron coatings on steel, Ameron coatings on concrete
 - Both sets of tests witnessed by USNRC for information

Confirmation of Adequacy of Current Practices

- Results to date:
 - All pull-off adhesion tests at or above 200 psig using an Elcometer Adhesion Tester as specified in ANSI N5.12
 - Most tests well in excess of 200 psig
 - Lowest test results adjacent to degraded CZ11/Phenoline 305 coatings on steel with high dry film thickness

Coating Failure Morphology Investigations

- USNRC NUREG/CR-6916, “Hydraulic Transport of Coatings Debris, “ December 2006
 - Examined settling and transport properties of various coating types found in US NPP Containments
 - Results commensurate with Industry findings

Coating Failure Morphology Investigations

- EPRI Technical Report 1009750, “Analysis of Pressurized Water Reactor Unqualified Original Equipment Manufacturer Coatings,” Final Report dated March 2005
- EPRI Technical Report 1011753, “Design Basis Accident Testing of Pressurized Water Reactor Unqualified Original Equipment Manufacturer Coatings, Final Report dated September 2005

Coating Failure Morphology Investigations

- The two EPRI Reports describe performance of OEM coatings exposed to a Radiation/DB-LOCA environment
- Results included:
 - OEM coatings failed in particles ranging in size from 5 μ m to 1025 μ m
 - Percentage of coating failure after DB-LOCA (all coatings) was 20.4% average (pre-irradiated) to 17.3% average (non-irradiated)
 - Percentage of coating failure after DB-LOCA (alkyd coatings only) was 33.9% average (pre-irradiated) to 23.4% average (non-irradiated)

Coating Failure Morphology Investigations

- Two-Phase Jet Impingement Testing to Determine Coating ZOI
- Testing involves exposing coated samples to a two phase jet of known pressure and temperature and stand-off distance; applying the ANSI/ANS-58.2-1988 model to calculate the jet centerline pressures and temperatures experienced at various distances from the nozzle; and determining a conservative damage pressure for each sample tested.
- The ANSI/ANS-58.2-1988 model using cold leg conditions and the coating damage pressure is used to determine the ZOI for the given coating.

Coating Failure Morphology Investigations

- Two ZOI test protocols have been performed to date:
 - Wyle Labs for Stars/USA Group
 - FPL/Areva (JOGAR Testing)
- Results of both test are proprietary; however, both tests indicate that the radii for spherical ZOI for most DBA-qualified coating systems is 4D or less

Coating Failure Morphology Investigations

- Design Basis Accident Testing of Failed Coating Debris (CPSES Unit 1)
 - Samples of failed Phenoline 305 / Carbo Zinc 11 coating exposed to DB-LOCA environment in autoclave equipped with 10 μ m filters
 - Samples placed in trays positioned in vapor phase and immersion zone of autoclave

Coating Failure Morphology Investigations

- Results of testing released for general industry use:
 - Coatings collected on 10 μ m filters ranged in size from 10 μ m to 100 μ m and was debris from IOZ primer. No traces of organic resin (topcoat) were found on filters.
 - Particles (chips) of topcoat ranging in size from 1/32 in. and up were found on the bottom of the autoclave.
 - Analysis of the autoclave condensate revealed no constituents of the topcoat resin

Summary

- ASTM Committee D-33 standards continue to provide appropriate guidance
- Containment Coating Condition Assessment in accordance with ASTM D 5163 (visual inspection followed by additional inspections if necessary) is being confirmed
- EPRI is proceeding with comprehensive study of coating aging
- Robust data is now available on coatings exposed to the DBA environment:
 - Epoxy, modified epoxy and modified phenolic coatings fail in the DBA environment as particles/chips 1/32 in. and larger
 - Alkyd and inorganic zinc coatings fail in the DBA environment as particles in the range of 10 μ m to 20 μ m
 - In general, DBA-qualified coatings exhibit a ZOI of 4D or less